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NUCLEAR ENERGY ACTIVITIES IN FOREIGN COUNTRIES

Volume II

Western Europe

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22 October 1956

CENTRAL INTELLIGENCE AGENCY

OFFICE OF SCIENTIFIC INTELLIGENCE

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PREFACE

The nuclear energy activities of certain selected foreign nations in four major geographic areas of the world have been surveyed, and the results are presented in a series of four publications. This volume contains information on the countries of Western Europe; volume I covers North and South America, volume III covers the Satellites and Communist China, and volume IV covers Asia and Africa.

The main topics considered for each country are the nuclear objectives, the organization and personnel by which a country will attempt to gain these objectives, the facilities and materials available and/or needed to do the job, and the intelligence evaluation of each nation's immediate potential in nuclear energy.

These reports are based on a detailed study of information available as of October 1955. It is planned to update the volumes on an annual basis.

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WESTERN EUROPE

SUMMARY

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NR

In continental western Europe, atomic energy commissions, or bodies formally charged with atomic energy matters, have been established in all the countries, with the exception of West Germany, and the latter is expected to do so shortly. All these programs, with the possible exception of that of France, have as their objective the development of atomic energy for power, propulsion, and general industrial applications.

France's program, which was established in 1945, now has two research reactors in operation as well as a plant for the processing and refining of uranium. The French effort is planned around a series of five-year nuclear research and development programs aimed at economic atomic power, but it should be noted that the French military forces are interested in developing both atomic weapons and propulsion. Research on the latter is already underway. Sufficient uranium reserves are believed to exist in France and its overseas territories to support their program as now planned.

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FRANCE

A. Organization, Control, and Objectives of the Program

The organization conducting atomic energy development in France is the Commissariat for Atomic Energy (CEA) established in 1945. It is scientific and technical in character and enjoys administrative and financial autonomy. The Commissariat is administered by an Atomic Energy Committee made up of ten members, with one appointed High Commissioner, reporting to the Prime Minister usually through a Cabinet Minister designated for the purpose. Generally, this latter Minister has been the Secretary of State to the Prime Minister. The present Faure Government, however, created a "Minister without Portfolio assigned to the Prime Minister" who is responsible for coordinating national defense (excluding the direction of the Armed Forces) and has under him the Commisariat for Atomic Energy, the Scientific Action Committee for National Defense, as well as other organizations.

The chief executive of the Commissariat is the Administrator-General or general manager, who is governed by the over-all policy established by the Atomic Energy Committee, which meets monthly.

To this structure, two industrial-type committees have been added: one on mining to give aid and advice to the CEA in this field; and one on industrial equipment. These two committees are used essentially to bring atomic energy problems to the attention of the major French industries. In March 1955, the French Government also appointed a 14-man Advisory Commission on the Production of Nuclear Power.

The French now have two research reactors in operation as well as a plant for the processing and refining of uranium.

The French atomic energy effort is planned around a series of five year nuclear research and development programs aimed at economic atomic power. However, it should be noted here that the French Military are interested in developing both nuclear weapons and nuclear prpulsion; research on the latter is already underway.

The first 5-year program, 1952-57, provides for the construction of a high-flux materials testing reactor, three new primary reactors (G-1, G-2, G-3) to produce plutonium (one of which is now under construction), and a plutonium processing plant. It also includes plans for training additional personnel in the field of nuclear physics and allows for an expansion of uranium mining and prospecting activities in France and the French overseas territories. Recently, the nuclear study center at Saclay inaugurated ninety courses designed especially for engineers in private industry.

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In May 1955, the French Government approved an expanded program calling for the expenditure of 100 billion francs (U.S. $286 million) during the last three years of the original 1952-57 program and 1958. The expanded program calls for the construction of a submarine reactor, and increased funds for basic research, treatment of ores, and production of reactor materials, especially heavy water.

A second 5-year program to start in 1957 will emphasize the construction of secondary reactors working from plutonium and the erection of pilot plants for the production of nuclear power. The third 5-year program, it is hoped, will see the actual construction of nuclear power plants capable of commercially sound operation.

Industrial participation in the French atomic energy program has been developing very slowly. At first, industrial participation was limited to supplying the CEA with equipment and materials. In addition, French chemical firms built the uranium factory at Le Bouchet, but the CEA operates it. After the departure of Joliot-Curie, however, the CEA began to make an increasing number of contracts with French industry for research and development of special materials and processes. Four of France's largest industrial concerns have been cooperating with the French CEA for the past two years under an industrial study arrangement. The most important activity of the group to date is cooperation with the CEA in the construction of its plutonium production site at Marcoule and the new materials testing reactor under construction at Saclay. In addition, two private companies, one for uranium prospecting and the other for heavy water production, have been formed by CEA direction. However, private French industry is not involved as deeply in the French atomic energy effort as it would like. French industry would like to get into development work in parallel with CEA activities. However, it is doubtful that the present French Government or the CEA would look with favor on private atomic development in France.

With regard to international activities, France has a contract with the Indian atomic energy program for studies on the use of beryllium oxide in reactors; a contract with Brazil to assist in the establishment of a uranium industry in Brazil; a contract with Israel under which France has financially contributed to Israeli studies on a method for producing heavy water and the development of a process to extract uranium from phosphates. France is a member of CERN and one of the countries discussing the formation of a joint European atomic energy project patterned after the Coal and Steel Community. In May 1955, France signed an agreement with the United Kingdom for the exchange of non-secret information on the development of the peaceful uses of atomic energy.

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B. Facilities in Existence or Planned

1. Reactors.—The French have two research reactors operating, one plutonium production reactor and a materials testing reactor under construction with others in the planning stage.

a. ZOE

Name: ZOE - Zero Energy Uranium Oxide Heavy Water (Eau Lourd) now designated EL-1.
Status: Operating. Went critical on December 15, 1948.
Location: Fort de Chatillon near Paris.
Purpose: Research
Materials:
Fuel - Natural uranium rods (2 tons), canned in aluminum sleeves.
Moderator - Heavy water (5 tons) (includes coolant)
Reflector - Graphite (65 tons)
Coolant - Heavy water. Bled away through a simple, light water heat exchanger.
Operating Conditions:
Total heat power - 150 KW
Neutron flux - 7×10^{11} n/cm^2/sec.
Comments: The reactor has been through a complete rebuilding program while retaining the same general physical structure. Originally the reactor had been fueled with three tons of raw uranium oxide.

b. P-2

Name: P-2 (Saclay) now designated EL-2
Status: Operating. Start-up took place in October 1952.
Location: Saclay, about 12-1/2 miles south of Paris
Purpose: Research and isotopes
Materials:
Fuel - 136 Natural uranium rods (3 tons)
Moderator - Heavy water (6 metric tons)
Reflector - Graphite (65 tons)
Coolant - CO_2 compressed to 7 Kg/cm^2 circulating at 60 m/s
Operating Conditions:
Total heat - 1500 KW
Neutron flux - 6 to 8×10^{12} n/cm^2/sec.

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Comments: When first operated the fuel elements vibrated dangerously requiring shutdown and repairs to prevent vibrations. With the original fuel elements it was possible to reach only 2/3 of the 1.5 MW design level. Therefore, a second set of fuel rods, designed to stand higher temperatures, was fabricated. However, the reactor has fallen, since February 1955, to half its power capacity. In June 1955, some difficulty was being experienced in operating it at even 600 watts. This poisoning may be due to some unsuspected corrosion some place in the system.

c. G-1

Name: G-1

Status: Under construction. Scheduled to be in full-scale operation by July 1956.

Location: Marcoule on Rhone River south of Lyon

Purpose: Plutonium production

Materials:

Fuel - Natural uranium (100 tons)

Moderator - Graphite (1500 tons)

Reflector -

Coolant - Air (6000 KW for pumping)

Operating Conditions:

Total heat power - 40,000 KW

Useful power output - 5,400 KW of 8,000 KW necessary for running reactor blowers and auxiliary services will be recovered.

Neutron flux - 3×10^{12} n/cm^2/sec.

Comments: G-1 is essentially an adaptation of the Brookhaven reactor.

d. EL-3

Name: EL-3

Status: Under construction. Scheduled for completion by the end of 1957.

Location: Saclay

Purpose: Materials testing under high flux density of fast neutrons

Materials:

Fuel - 1/2 ton of fuel with twice natural amount of U-235. France would like to obtain enriched uranium from the United Kingdom or United States if possible.

Moderator - Heavy water

Reflector -

Coolant - Heavy water

[redacted]

Operating Conditions:
Total heat power - about 15,000 KW
Neutron flux - aims at 10^{14} n/cm^2/sec, will probably be 6 to 8 x 10^{13} n/cm^2/sec

Comments: Designed along the lines of the P-2 reactor at Saclay but more powerful and to operate at a much higher temperature. Orders for 10 or 12 tons of heavy water have been placed with Norway.

e. G-2 & G-3

Name: G-2 and G-3 (to be identical and adjoining units)
Status: Planned. Plan construction during 1956; with full-scale operation expected in late 1957.
Location: Marcoule on Rhone River south of Lyon
Purpose: Plutonium production
Materials:
Fuel - Natural uranium (100 tons)
Moderator - Graphite (1000 metric tons)
Reflector -
Coolant - CO_2 gas under pressure (9 Kg/cm^2)
Operating Conditions:
Total heat power - 100,000 KW (each)
Useful power output - 20,000 to 30,000 KW expected (each)
Neutron flux - 7 x 10^{12} n/cm^2/sec

f. Submarine Reactor

Name: Submarine Reactor
Status: Planned
Location:
Purpose: Mobile power (submarine)
Materials:
Fuel - Natural uranium
Moderator - Beryllium
Reflector -
Coolant - Ordinary water (probably)
Operating Conditions:
Total heat power - 50,000 KW
Neutron flux -

Comments: The French have reported that all problems attendant to the development of this reactor had been solved, including those of heat transfer and reactor size but no reliable details are as yet available.

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Two additional research reactors are planned by the CEA. The following details on them are available. France is obtaining 30 tons of heavy water from the United States which will be used in two experimental reactors at Saclay. One has the following specifications: A NRX-type reactor with refrigerated heavy water. The power will be 50,000 KW; and the flux will be 10^{14} n/cm^2/sec. The second reactor has the following specifications: A small reactor to measure effective nuclear cross sections and to control the nuclear purity of materials. This reactor would require 4 tons of heavy water. The power would be 100 KW; and the flux would be low.

2. Types of Isotope Separators.--There are small electromagnetic separators at the College de France (Perrin's Laboratory) and at Chatillon. The CEA High Commissioner, Francis Perrin, recently announced that France has begun studies on the separation of U-235 by gaseous diffusion for use in reactors. There is no indication that the work is on a large scale or that it is being pushed very hard.

3. Research Facilities.--The research facilities of the CEA are located at Chatillon and Saclay, both centers near Paris.

Chatillon was the first center established by CEA and is the site of France's first research reactor, ZOE, which was completed in 1948. ZOE has been used as a scientific tool for the production of radioisotopes and for the irradiation of various materials. A study of pile fluctuations has been undertaken. This has led to ZOE's use as a control instrument for uranium purity. Research is also underway at Chatillon in the following fields: metallurgy, applied chemistry, mineralogy, biology, and physical chemistry. A plutonium extraction pilot plant has been constructed at Chatillon for the CEA by the St. GOBAIN Glass Company. The central offices of the Mineral Prospecting and Exploration Service of the CEA are also located at Chatillon.

Saclay is the site of the second research reactor, P-1, and of the materials testing reactor now under construction. Other research facilities at Saclay include a 25 MEV cyclotron and a 4.5 MEV Van de Graaff, both constructed by the CEA. The CEA is constructing a 1.7 Bev proton-synchrotron at Saclay. Construction of the machine is expected to be completed in 1957. In addition to the Pile Studies Department and accelerator group at Saclay, there are research groups working on radiation protection, nuclear physics, electric construction, mechanical studies, etc.

There are two betatrons in France, neither of which is owned or operated by the CEA. One, built by Allis Chalmers, is used at the Gustave Roussy Institute for biological work. A newer, 30 MEV instrument is operated by the French Military at Fort d'Issy les Moulineaux.

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In addition to the cyclotron at Saclay, there is a 6.8 MEV cyclotron at the College de France which is under the direct supervision of Frederic Joliot-Curie.

There are several Van de Graaff generators in France with the most important one at Saclay.

D. <u>Supporting Industry and Institutions</u>

1. <u>Industry</u>.—Four of France's largest industrial concerns have been cooperating with the French CEA for the past two years under an industrial study arrangement. The Companies are: The Societe Alsacienne de Constructions Mecaniques, the Societe Alsthom, the Societe des Forges et Acieries du Creusot (SCHNEIDER), and the Societe Rateau.

The most important activity of the group to date is cooperation with the CEA in the construction of the Marcoule reactor center, and the new materials testing reactor at Saclay. The responsibilities of the four companies were divided as follows with regard to the first production reactor at Marcoule: The Societe des Forges et Acieries du Creusot was entrusted with the over-all responsibility and with erection of the pile block and layout of the graphite factory; the Societe Rateau developed and fabricated the pile cooling system, including blowers, filters and fans; the Societe Alsacienne de Constructions Mecaniques built the equipment for inserting and extracting the uranium slugs from the pile, and the Societe Alsthom furnished the high voltage equipment, including the electric motors which operate the blowers.

Recently, in connection with work involving the second reactor at Marcoule and the materials testing reactor at Saclay, the group has been enlarged to include the Societe des Chantiers de la Loire and Schneider - Poelman.

Saint-Gobain, the company which built the pilot plant at Chatillon for the separation and refinement of plutonium, is responsible for the plant at Marcoule which will extract plutonium produced in the three reactors there.

In addition, Electricite de France is building the electric generator to provide power from the first Marcoule reactor.

The following French firms are the major concerns supporting the work of the French CEA, either through supply of materials and equipment or by research contract:

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L'air Liquide--Working on production of heavy water by fractional distillation of hydrogen (research contract)

Compagnie Francaise Thomson-Houston--Closely connected with General Electric of U. S. Working on electrical construction and electronics work for CEA reactor program (research contract).

Compagnie Generale de Telegraphie-Sans Fils--Under research contract to CEA on (1) preparation of zirconium metal (powder methods) and (2) zirconium metallurgy (powder methods). Has also concluded an agreement with the Accelerator Service of the CEA covering the training of engineers.

Consortium de Products Chimiques et de Synthese--Under contract for production of special chemical reagents for plutonium separation.

Pechiney--Under research and industrial contract to CEA. Pechiney supplies pure graphite (moderator grade) to the CEA. The Company also extrudes uranium rods for the CEA. It is under research contract for the following:

1. production of pure beryllium oxide for moderators and powdered beryllium metal.

2. canning problems with beryllium and other light alloys.

3. production of zirconium metal (powder methods).

4. zirconium metallurgy (powder-methods).

5. preparation of hafnium-free zirconium.

6. prospection for uranium in the aluminum phosphates of Senegal.

Societe d'Electro-Chimie d'Electro-Metallurgie et des Aceries Electriques d'Ugine--Under research and industrial contract to the CEA. Ugine supplies pure hydrofluoric acid and hydrogen peroxide for uranium purification. The company is conducting research for the CEA on:

1. production of zirconium metal (powder methods) for canning.

2. zirconium metallurgy (powder methods) for canning.

Societe-Electrometallurgique du Planet--Supplies pure calcium metal used in uranium purification.

[redacted]

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Societe Minerais et Metaux--Acts as an engineering consultant to the CEA at Le Bouchet. Designed physical beneficiation part of Le Bouchet plant for treatment of uranium ores.

Societe des Phosphates Tunisiens--Under research contract to the CEA for:

1. extraction of uranium from low-grade Moroccan (lime) phosphates.

2. production of heavy water. The Company has modified its electrolytic installations in its Soulom factory with the idea of producing a heavy water concentrate.

Societe Potasse et Engrais Chimiques--Under research contract to the CEA on:

1. physical beneficiation of low-grade uranium ores.

2. extraction of uranium from low-grade Moroccan (lime) phosphates. The company designed and built the chemical treatment plant for beneficiation of low-grade uranium ores at Le Bouchet.

Societe de Produits Chimiques des Terres-Rares (STR)--Under research (and once under industrial) contract to the CEA. STR designed the plant equipment at LeBouchet for purifying uranium and uranium oxide. It is now working on the successive fractionation method for obtaining hafnium-free zirconium, STR is also interested in selling uranium purification methods abroad (India, Brazil, etc.). The CEA is not involved in this latter activity.

Saint Gobain--In addition to its work for the CEA on the design and construction of the plutonium extraction plant, St. Gobain is conducting research on the recovery of uranium from low-grade Moroccan (lime) phosphate.

Societe des Usines Chimiques Rhone-Poulenc--Under industrial contract to the CEA for the supply of special chemical reagents for plutonium separation.

Manufactures de Produits Chimiques du Nord (Establissements Kuhlmann)--Under research contract for work on extraction of uranium from low-grade Moroccan (lime) phosphates.

Trefileries et Laminoirs du Havre--Under contract on the study and semi-finished manufacture of aluminum magnesium and the magnesium aluminum alloys.

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Societe General du Magnesium--Under contract for the manufacture of smooth and profiled tubes of magnesium.

Societe des Produits de Chimie de Thann et Mulhouse--Under research contract to CEA for the production of hafnium-free zirconium.

The two private companies that have been formed, largely at the direction of the CEA, are the Compagnie Francaise des Minerais d'Uranium and Compagnie Francaise de l'eau Lourde.

The CEA holds 15 percent of the capital and is represented on the Board of Directors of Compagnie Francaise des Minerais d'Uranium which was formed in February 1955. The founding member of the company is the banking group of Rothschild Freres. Six private concerns, including Pechiney and Establissements Kunlmann, are also shareholders and are represented on the board. The company is being set up to secure French industrial capital for exploration activities and to establish a uranium ore concentration plant near recently discovered uranium deposits in the Vendee.

Compagnie Francaise de l'Eau Lourde was formed in December 1954 with the objective of constructing at Toulouse a pilot plant for the production of heavy water by the distillation of liquid hydrogen. Shares in the company are held equally between the State industry for the production of nitrogen, and a private company, L'Air Liquide. The establishment of the company was decided by CEA, based on a study made by L'Air Liquide. The company has been granted a state loan of 100 million francs.

2. Institutions.--Information on exterior laboratories contracting with the CEA on research projects is only available on the years of 1952 and 1953. From the information available on both these years, it is clear that no ideological discrimination is being made and that contracts are awarded to communist as well as non-communist scientists. In 1952 the contracts totalled 69,687,000 francs (U.S. $200,000); in 1953 the contract totalled 84,175,000 or U.S. $240,000. The percentage of the total appropriation allocated to the Joliots decreased significantly in 1953 - from 31.5 percent of the total in 1952 to 22.7 percent of the total in 1953.

In 1952, the CEA underwrote research in some twenty-six university laboratories and research institutes, and 35 in 1953. Research was supported in the fields of physics, chemistry and physical chemistry, metallurgy, mineralogy, and biology. Details and lists of publications resulting from the research are available.

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E. Supporting Personnel

The great shortage in France of technically trained personnel has resulted in a decision to use all men available whether politically reliable or not.

In the beginning of 1955, approximately 6,500 people were employed by the CEA. Of this number 4,350 are employed in its prospecting and mineral exploitation program; with 1,350 employed in this capacity in Metropolitan France and 3,000 in the overseas territories. For the years 1955, 1956, and 1957, the total recruitment contemplated of scientific and technical personnel is respectively 300,450, and 600.

In order to insure an increasing supply of trained personnel, the CEA requested the Ministry of National Education in February 1955 to organize a "Third Training Cycle" (post-graduate training following the Licenciate degree) in the nuclear sciences. In addition, it requested that the following extra educational facilities be provided starting October 1955:

1. At Lyon, a section on theoretical physics, and sections on physics, nuclear physics, nuclear chemistry, and chemistry.

2. At Toulouse, a section on electronics.

3. At Grenoble, a section on electronics, and a section on nuclear physics and chemistry.

4. At Strasbourg, a section on nuclear physics and chemistry.

5. At Paris, a section on physical chemistry and a section on theoretical physics.

The request also stated that increased research equipment, particularly accelerators, should be acquired in the training centers. For Paris, at the Sorbonne, a 100-MEV synchrocyclotron has been ordered, and a 2-MEV particle accelerator and an isotope separator have been proposed. For Strasbourg, a 6-MEV accelerator is planned as well as an accelerator for Lyon and one for Grenoble. The Laboratory for Atomic Syntheses at Ivry should be furnished with a betatron, and the Ecole Normale Superieure, a 2-MEV accelerator.

The request also recalled that the CEA had organized in 1954 at the Sorbonne training courses for students coming out of the national engineering schools. Some 100 students have already taken this course.

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France has also participated in U.S. training programs offered under the "Atoms for Peace" program.

Two French students participated in the first course of the reactor training school at Argonne, and four have been selected to attend the second session which opened in the fall of 1955.

Key personnel of the French CEA are as follows:

Prime Minister's Representative -- Minister without Portfolio assigned to the Prime Minister. The CEA reports to the Prime Minister through this person. Because of changes in the French cabinet over the Moroccan situation the name of the person filling this position is not known.

The Government Delegate — Pierre Guillaumat - Administrator-General. Serves as a Commissioner of the CEA in the capacity of the Government's delegate. Most important position in CEA. As Chief Executive Officer is responsible for all contractual arrangements and personnel actions. Born 1909. From a prominent military family. Graduated from the Ecole Polytechnique, Paris, in 1930. In 1931 became a member of the Corps des Mines, a select professional body whose members fill many top positions in French industry and French bureaucracy. Followed career of a mining engineer until the outbreak of World War II when he was called from Indochina to Tunisia to become Director of Mines, including petroleum affairs in the French Protectorate Government. In 1943, became Colonel in French Army and assumed charge of petroleum affairs for all of North Africa. Became Director of Petroleum Affairs for France (petroleum agency is a government monopoly in France) in 1945. Appointed to present position with CEA in 1951.

High Commissioner or Technical Director — Francis Perrin - Succeeded Frederic Joliot-Curie as High Commissioner in April 1951. Holds Chair of Atomic and Molecular Physics, College de France. Born 1901. Son of late Jean Perrin, prominent scientist. Attended secondary school in New York City when father was conducting graduate seminars at Columbia University in 1913. Received higher education at Ecole Normale Superieure in Paris. Early researcher in nuclear physics with Joliot-Curie, Kowarski, and van Halban prior to World War II. Professor at New York School for Social Research 1941-43. Returned to France at end of World War II and helped organize CEA. Married to Colette Auger, sister of Pierre Auger, prominent French scientist with UNESCO.

Atomic Energy Committee

Pierre Ailleret — Director of Studies and Research at Electricite de France.

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Roger Belin -- Maitre des Requestes in the Council of State assigned to the Government's Secretariat General.

General Jean Guerin -- Head of the Scientific Committee for National Defense, which is charged with coordinating entire field and development related to national defense.

Jean Marc Boegner -- Formerly head of the Services des Pactes at the Foreign Office. Under Faure Government, is Directeur de Cabinet under "Minister without Portfolio assigned to the Prime Minister."

Gaston Dupouy -- Director of the Centre National de Recherche Scientifique, a government agency which subsidizes non-military research in France.

Roger Goetze -- Director of the French Budget.

Pierre Guillaumat -- See above.

Louis Leprince-Ringuet -- Cosmic ray specialist. Professor, Ecole Polytechnique.

Francis Perrin -- See above.

Yves Rocard -- Professor of Physics and Mathematics at the University of Paris and Ecole Normale Superieure. Director of Physics and Electronics Research, French Navy.

Key Scientific and Technical Personnel of the French CEA:

Henri Piatier -- Chef du Cabinet

Counselors -- Lew Kowarski - working full-time for CERN; Eugene Lemeur - formerly head of Mechanical Studies section at Saclay.

Bertrand Goldschmidt -- A radio-chemist. Director, Department of Chemistry; Director of Public and Foreign Relations, CEA. Worked at Montreal and Chalk River atomic energy projects during World War II. Returned from Canada to France at the end of the war and helped to organize the scientific and technical services of the newly established French CEA. Official French observer at the Bikini tests in 1946.

Jules Gueron -- Director of Planning; Director of the Department of Physical Chemistry, CEA. Worked in Canada with Goldschmidt during World War II. Returned to France after the war and helped to organize scientific and technical services of the newly established French CEA. Advisor to French delegation to UN Atomic Energy Commission from 1946-49.

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Jacques Mabile -- Director of the Research and Mineral Exploitation Service.

Pierre Taranger -- Industrial Manager in charge of the Marcoule Center.

Jules Rayrond Maillet -- Director, Large Accelerators. Industrialist, president of Societe Electrometallurgie du Planet, producer of calcium for the CEA.

Jacques Asty -- Director in Charge of General Administration. Naval engineer.

Key Scientific and Technical Personnel at CEA Installations

Chatillon

Charles Eichner	Chief, Dept. of Metallurgy and Applied Chemistry

Section Heads

Jean Chervet	Mineralogy
Jean Coursaget	Biology
Andre Ertaud	Chatillon pile (EL-1)
Hermann Herring	Physical Chemistry
Pierre Regnaut	Plutonium

Section Heads, Mineral Prospecting and Exploitation

Andre Lenoble	Prospection Missions
Lucien Vuchot	Exploitations
Andre Ginocchio	Concentration of ores

Saclay

Jean Debiesse	Director, Saclay Center
Jacques Yvon	Chief, Pile Studies Dept.

Section Heads

Yves Aubineau	Documentation
Andre Berthelot	Nuclear Physics
Henri Jammet	Radiation Protection
Pierre Lamy	Mechanical Workshops
Pierre Descans	Mechanical Studies
Jacques Stohr	Technology
Maurice Surdin	Electric Construction
Stanislas Winter	Accelerators
Mr. Uguen	Saclay Pile (EL-2)

[redacted]

Le Bouchet Factory

Bertrand Goldschmidt	Scientific Director
Paul Vertes	Director of Factory

Information about a considerable number of these persons is available, together with information concerning a substantial percentage of persons reporting to them.

F. Supporting Funds

First expenditures in the atomic energy field were made in 1946 and totalled $350,000*. The accumulative total spent through 1951 was about $33,900,000.

The first five-year program, which is to extend over the period 1952-1957, called for the expenditure of $107,000,000. Under authorization of this program, $14,800,000 were spent in 1952; $17,300,000 in 1953; with expenses running about $22 to$25,000,000 in 1954.

In May 1955, the French Cabinet approved an expanded program for the last three years of the 5-year program (1955-57) and 1958 calling for the expenditure of $286,000,000. Actually, the $286 million is a total figure which includes authorizations left over from previous appropriations and as yet unspent. In addition, authorization for about $48 million of the total sum remains to be sought.

G. Availability of Materials and Equipment

1. Source Materials.—

a. Uranium

Ultimate uranium resources may be on the order of 1 to 3 tens of thousands of tons; largely in Metropolitan France. Many occurrences, but insignificant reserves, are known in the Colonies. Prospecting and ore concentrating activities are carried out by the Mineral Prospecting and Exploitation Service (DREM) of the CEA. Under the DREM, a large and well organized exploration program is underway throughout France and the Colonies.

The DREM has four divisions in Metropolitan France which are either producing or are under development for uranium. The four divisions are: The La Crouzille Division; the Lachaux Division; the Vendee Division; the Grury Division.

*These figures assume 350 francs = U.S. $1.00

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The CEA's Le Bouchet factory for uranium metal production is operating at present to produce 25 to 30 tons of metal a year. This can be scaled up fourfold fairly readily.

Details of the French uranium purification system are available. The purity of the metal is reported to be better than that obtained by the British. The current French process for uranium purification appears not unusual. Sodium uranate is dissolved in nitric acid, stripped with hexone, precipitated by hydrogen peroxide and eventually turned into the green salt which is ignited in the presence of calcium. The final product appears as 30-40 Kg slugs containing 30-50 ppm of iron equivalent.

b. Thorium

Moderate thorium reserves exist in Madagascar where a modest production is being obtained. About 7 metric tons (oxide equivalent) had been stockpiled by the CEA by January 1953. Under an agreement with the United Kingdom the U.K. Atomic Energy Authority will provide the CEA with approximately 2 tons of thorium bar by the end of 1955 for experimental purposes.

The CEA plans to have the Societes des Potasses et Engrais Chimiques build a factory for the treatment of thorium ores. Several French chemical firms, particularly Societe de Produits des Terres Rares, have had long experience in the processing of thorium.

c. Heavy Water

The CEA obtained the heavy water for its two reactors, ZOE and P-1, from Norway. Ten tons of heavy water are on order from Norway for EL-3. The United States has also agreed to sell France 30 tons of heavy water for two additional research reactors with delivery scheduled for 1956 through 1958.

In addition, the CEA with French Industry is studying the problem of heavy water production. The Societe des Phosphates Tunisiens has modified its electrolytic installations in the Soulom factory with the idea of producing a heavy water concentrate. The Societe l'Air Liquide is studying the fractional distillation of liquid hydrogen method. A new French company, Compagnie Francaise de l'Eau Lourde, was formed in December 1954 with shares held equally between the State industry for the production of nitrogen and L'Air Liquide, for the manufacture of heavy water. The new company will construct a pilot plant near Toulouse and use the method developed by L'Air Liquide.

[redacted]

[redacted]

The United Kingdom and France, under the terms of the agreement signed in May 1955, will exchange information and studies on the various heavy water production methods.

d. Graphite

Nuclear pure graphite (moderator grade) is produced for the CEA by Pechiney. Pechiney's current production rate is about 300 tons a year. The density of the graphite is between 1.65 and 1.68, and the diffusion length is around 55 cm. The graphite contains about 2/10 ppm of boron.

e. Beryl

Beryl is available in fairly substantial quantities from Madagascar. In 1953, the CEA had a stockpile of about 1,000 tons of beryl and was interested in selling future production.

Studies on the production of very pure beryllium oxide and metal are underway by the CEA and various French chemical firms. (See Supporting Industries, D-1.) The CEA is reported to be getting ready for an exponential pile assembly using beryllium oxide as the moderator.

f. Zirconium

Zirconium can presumably be purchased through private channels from Brazil. Studies on the production of very pure zirconium for use in the atomic energy program are being made by the CEA and various French-British agreement concluded in May 1955, the U.K. Atomic Energy Authority and the French CEA will exchange information on production methods, mechanical and metallurgical treatment of beryllium and zirconium of nuclear purity and of alloyws of these materials or of aluminum and magnesium, which can be used in sheathing uranium.

H. General Estimate of Growth in the Next Five Years

France in the next two to three years will have completed the construction of two and perhaps three plutonium production reactors, a plutonium extraction plant, and a materials testing reactor. Plutonium, in kilogram quantities, will be available from the first production reactor in mid-1957, with that from the second expected in late 1958. According to present plans, the plutonium produced will be used in power, and possibly, propulsion reactors. Although studies are being made toward this end, France would prefer to obtain power reactor information from either the United States or the United Kingdom before undertaking the actual development of the power program.

[redacted]

If French industry does not obtain free access in the atomic energy field, the French economy will never support, on government funds alone, the full-fledged atomic power development the country needs. French Government narrow-mindedness is such that atomic development will take years longer to come to fruition if restricted to the narrow governmental channels.

France's accelerated efforts on the training of personnel and the development of source materials will undoubtedly result in a measure of success in the next five years.